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Beneficial Bloodsucking

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ABSTRACT

The bite of the lone star tick spreads alpha-gal syndrome (AGS), a condition whose only effect is the creation of a severe but nonfatal red meat allergy. Public health departments warn against lone star ticks and AGS, and scientists are working to develop an inoculation to AGS. Herein, we argue that if eating meat is morally impermissible, then efforts to prevent the spread of tickborne AGS are also morally impermissible. After explaining the symptoms of AGS and how they are transmitted via ticks, we argue that tickborne AGS is a moral bioenhancer if and when it motivates people to stop eating meat. We then defend what we call the Convergence Argument: If x-ing prevents the world from becoming a significantly worse place, doesn't violate anyone's rights, and promotes virtuous action or character, then x-ing is strongly *pro tanto* obligatory; promoting tickborne AGS satisfies each of these conditions. Therefore, promoting tickborne AGS is strongly *pro tanto* obligatory. It is presently feasible to genetically edit the disease-carrying capacity of ticks. If this practice can be applied to ticks carrying AGS, then promoting the proliferation of tickborne AGS is morally obligatory.

1 | Introduction

Among the best and most widely accepted arguments in applied ethics are those concluding that eating meat is morally wrong.[1] Their premises, logic, and conclusions differ. However, broadly, they end in one of two claims: (a) that eating meat is wrong, or (b) that eating factory farmed meat is wrong.

Arguments concluding (a) or (b) have influenced dietary shifts in scores of people, theorists and lay alike, to forego eating meat or factory farmed meat.[2] Ingrid Newkirk, the founder of People for the Ethical Treatment of Animals (PETA), cites the publication of Peter Singer's 1975 book, *Animal Liberation*, as a primary motivation for her to form PETA [3]. Their application has been profound, likely leading to significant changes in policies related to the regulation of meat production and selling, as well as in the eating preferences, practices, and habits of millions of people.[3]

Throughout this paper, we assume there is a *pro tanto* obligation not to eat meat. For the sake of brevity, we do not introduce any of the countless arguments concluding that eating meat is wrong. We have nothing to add to these arguments, and assume that readers have sufficient familiarity with why eating meat might be wrong. Instead, we stipulate that eating meat is wrong. This amounts to the stipulation that grounds the forthcoming theorizing: If there are strong moral reasons to not eat meat, then there is a *pro tanto* obligation to not eat meat. Much of this paper pertains to other considerations that may override this obligation and permit someone to eat meat. Regardless of whether these considerations are sufficient to do so, there is always moral disvalue in eating meat.

Our main conclusion is that we should promote a particular tickborne syndrome: alpha-gal syndrome (AGS). AGS is caused by the allergen alpha-gal, which in humans causes an allergic reaction to eating mammalian meat and mammalian organs. People who have the allergy may have a variety of symptoms, including hives, gastrointestinal upset (e.g., vomiting and diarrhea), or anaphylaxis in severe cases. Often, these symptoms present 2–6 h after ingestion of mammalian meat. However, there is little reason to believe that there are additional harms

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associated with the allergy, aside from the allergic reaction itself. Although AGS is typically associated with the lone star tick (LST), other ticks also transmit AGS.

AGS promotes in the people who have it a resistance to eating mammalian meat. Thus, they eat less mammalian meat, which is an improvement in their capacity for moral behavior. It helps them satisfy their obligation not to eat meat, an obligation they would otherwise be disinclined to satisfy; the allergy presents only after eating meat: no meat, no allergic reaction. In short, when a tick sucks human blood and transmits AGS, it enhances the moral capacities of the person it bites; the AGS-transmitting tick is a moral bioenhancer. The more they transmit AGS, the better they and the world will be.

We aim to establish the main claim that we should promote the proliferation of AGS by promoting the ticks that transmit it. To be clear, we do not argue that, today, we are morally obligated to promote the spread of tickborne AGS, because presently it is not possible to do so. But it is feasible to genetically edit the disease-carrying capacity of ticks. If we are right, then today we have the obligation to research and develop the capacity to proliferate tickborne AGS and, tomorrow, carry out that proliferation.

In the next section, we introduce AGS and its etiology, both of which are relatively recent scientific discoveries. In the third section, we defend the *Convergence Argument*: Because promoting tickborne AGS prevents something bad from happening, doesn't violate anyone's rights, and promotes virtuous action or character, it follows that promoting tickborne AGS is strongly *pro tanto* morally obligatory. We call our argument the "*Convergence Argument*" because it emphasizes normative convergence across three major ethical theories: consequentialism, rights-based deontology, and virtue ethics. After defending the arguments for each premise of the Convergence Argument, we proceed in Section 4 to consider an alternative proposal, whereby AGS is synthesized and used a moral bioenhancement. In Section 5, we consider and rebut 10 objections to our central thesis and the arguments for it.

2 | Background Assumptions

2.1 | When Eating Meat Is Wrong

To say that one has a *pro tanto* obligation not to eat meat is just to say that, absent some justification, one shouldn't eat meat. Yet even when committing an act that is *pro tanto* wrong but all-things-considered justified, there remains some moral disvalue in committing it. It's just that failing to act in alternative ways would require an even greater sacrifice of moral value.

Even if one refrains from eating meat, one still has a stake in whether others do so. Not only does eating meat impose significant risks to public health, but presumably everyone has some stake in the moral actions of others. One may not be obligated to try to prevent others from acting wrongly, but one must not facilitate others' wrong actions. It is common to find such a facilitation similarly, if not equally, wrong. However, it is at least permissible to try to prevent wrong action, at least when such action involves failing to discharge an *enforceable* moral obligation. When someone engages in enforceable wrongdoing X, they violate an enforceable obligation to refrain from X-ing. Because acting to enforce an enforceable obligation is permissible, and because blocking permissible behavior is *pro tanto* impermissible, it follows that blocking someone from enforcing an enforceable obligation is *pro tanto* impermissible. Even weaker, it is permissible to stay out of the way of others who permissibly attempt to prevent (again, enforceable) wrong action. Likewise, one must not block others' attempts to prevent wrong actions.

In Section 3, we show how promoting tickborne AGS is a permissible method of preventing meat-eating and how blocking others' attempts at promotion would be impermissible.

2.2 | Alpha-Gal Syndrome and Tickborne Diseases

Although the first description of AGS was published in the early twentieth century, the evidence leading to its identification as a tickborne syndrome has only coalesced in the past two decades [6]. This recent identification is primarily because of two features of the syndrome. First, the symptoms can vary significantly between individuals with AGS and within individuals with AGS [7]. Furthermore, the onset of symptoms often occurs several hours after the ingestion of meat, which makes associating the symptoms with their cause more difficult than, for example, anaphylaxis immediately after a bee sting [7]. Second, AGS is highly regional and significantly associated with the prevalence and frequency of tick bites [7]. Not only must the ticks (often the LST) be present in the local environment, but the humans in that environment must also be mammalian meat-eaters [7]. This combination of factors delayed discovery of the syndrome [7].

Alpha-gal syndrome is characterized by an immune response to alpha-gal, which is released by the tick when it bites a human. Alpha-gal syndrome occurs when the human immune system releases the Immunoglobulin E (IgE) antigen in response [7]. Symptoms vary within and between AGS patients. Notably, they typically do not occur until well after eating meat (2–6 h). These include hives and anaphylaxis, as well as gastrointestinal upset, which may confound one's ability to correlate the symptoms (vomiting and diarrhea) with its cause (eating meat) [7]. An allergic reaction to meat may then occur for the remainder of the person's otherwise typical life [7].

Not every tick that releases alpha-gal causes AGS, and this syndrome remains uncommon. However, it occurs primarily in areas where people commonly eat mammalian meat and are bitten by ticks. As climate change expands the survivability range of ticks, it is plausible that AGS will become more prevalent, especially if mammalian meat-eating doesn't subside. Even now, the prevalence of AGS is increasing not only in the regions in which it has typically presented, such as the Southeastern United States, but also in the Upper Midwest and the Northeast.

Importantly, there is little evidence that AGS is associated with potentially harmful conditions, apart from those that are caused

by eating meat. Indeed, our claim rests on the notion that AGS causes some harm to the person with the syndrome such that they are motivated to refrain from eating meat. There are some indications that it is associated with a slight increase in risk of cardiovascular disease, perhaps due to more systemic increase in inflammation. However, this evidence remains preliminary. Furthermore, if people with AGS cease eating mammalian meat, their risk of cardiovascular disease will presumably decrease because eating mammalian meat is a significant contributor to the development of the disease. Still, people with AGS presumably are already avoiding eating mammalian meat, so the speculative cardiovascular benefits from AGS may already be accounted for in the evidence base. Finally, there is considerable evidence that eating meat itself poses cardiovascular risks [8], and thus removing meat from a person's diet is correlated with a decrease in cardiovascular risk [9–11]. AGS itself is safe, so long as a person with AGS refrains from eating mammalian meat.

While some note case reports of people with AGS experiencing negative reactions to the use of mammalian-based products in cardiovascular procedures and in people receiving large doses of heparin [12], a more recent review found these reactions to be rare and alternatives with no evidence of reaction available [13].

There are a handful of case reports that some people with AGS experience fatal anaphylaxis upon being treated with cetuximab [14], which is a secondary treatment for colorectal cancer (the likelihood of which increases with red meat consumption). These instances of fatal anaphylaxis are rare, as are numerous other serious unanticipated adverse events associated with many common and widely distributed interventions [15].

But lone star ticks transmit more than AGS. They can also transmit several other conditions. Most of these resolve quickly and independently. However, some conditions, such as tularemia and ehrlichiosis, can be serious and rarely fatal. The possibility that these diseases could proliferate along with AGS threatens the permissibility of our recommendations.

For the purposes of this paper, the relevant empirical points are (i) that AGS causes a range of symptoms in response to eating mammalian meat, (ii) that there are no significant associated secondary harms of AGS itself, (iii) that AGS is increasing in prevalence, and (iv) that the lone star tick can also transmit other conditions. Given these points, we argue that researchers and the public should promote the widespread transmission of AGS, starting with immediate research and development of a tick's ability to carry and transmit AGS.

2.3 | Editing the Lone Star Tick

The primary obstacle to the permissibility of our recommendation is that lone star ticks can transmit other conditions, which can cause serious harm, including death. Primarily, in addition to tularemia and ehrlichiosis, the lone star tick can transmit diseases that cause mild infections and rashes, which, though rather ordinary and common in the scope of human disease, still count. However, these are not the conditions that most undermine the potential permissibility of our recommendation because, in most cases, these symptoms and outcomes do not significantly undermine a person's interests.

The permissibility of our recommendation depends on the feasibility of genetically editing the lone star tick in several ways: (a) engineer the lone star tick to carry AGS; (b) engineer the lone star tick so that it can survive and proliferate in more widespread conditions; and (c) engineer the lone star tick so that it does not transmit other diseases, primarily tularemia and ehrlichiosis.

This may seem like a tall order. So many recommendations in biomedical ethics remain dependent on distant and implausible scientific advancements. But in this case, the necessary advancements are not too far off, if not already enacted. The feasibility of (b) is clear, as it has been observed with mosquitoes. As a means of abating the transmission of mosquito-borne diseases, municipalities are already using gene-editing technology to manipulate the ability of disease-free mosquitoes to reproduce and proliferate. These mosquitoes can take over local populations but are then unable to proliferate beyond a generation, thus eliminating the disease-carrying mosquito over time [16–18]. It is plausible that similar techniques could manipulate ticks so that they can more easily spread in different environments and proliferate more widely.

It may also be feasible soon to enact (c), the manipulation of lone star ticks so that they don't transmit tularemia and ehrlichiosis. Scientists have already demonstrated the ability to edit other ticks to be free of Lyme disease. Using CRISPR, scientists have shown that they can essentially cut out the genetic foundation of a tick's ability to carry Lyme (which is much more common and often very harmful) [19]. If they can do it with Lyme, they may also be able to do it for ehrlichiosis and tularemia (especially the former, as it, like Lyme, is also caused by spirochetes, whereas tularemia is bacterial).

Whereas gene editing is the bioethicist's favorite solution, science is often far from being sufficiently feasible to realize bioethicists' consideration. However, given the feasibility of both (b) and (c), it is plausible that (a) lone star ticks can be genetically engineered to carry AGS. If so, and given that these ticks may be free of tularemia and ehrlichiosis and that, like other pests, may be engineered to populate and proliferate, our recommendation is plausibly feasible.

3 | Promoting Tickborne AGS

We begin by laying out our central argument for the *pro tanto* obligation to promote tickborne AGS. That argument runs as follows:

3.1 | The Convergence Argument

1. If x-ing (A) prevents the world from becoming a significantly worse place, (B) doesn't violate anyone's rights, and (C) promotes virtuous action or character, then x-ing is strongly *pro tanto* morally obligatory.

2. Promoting tickborne AGS (A) prevents the world from becoming a significantly worse place, (B) doesn't violate anyone's rights, and (C) promotes virtuous action or character.
3. So, promoting tickborne AGS is strongly *pro tanto* morally obligatory.

We call this argument the "Convergence Argument" because it outlines conditions jointly sufficient for a morally obligatory action under dominant ethical theories: consequentialism (2A), rights-based deontology (2B), and virtue ethics (2C).

In (1B) and (2B) we rely on a distinction between a violation of one's rights and an infringement upon one's rights. An infringement, but not a violation, is a justifiable transgression of rights. For example, public health measures like vaccination don't violate (even if they infringe) people's right against bodily interference and coercion. Tickborne AGS, as we argue below, doesn't violate (although in many cases it may infringe) people's right against bodily interference and coercion.

Consequentialists universally accept that preventing the world from becoming a significantly worse place is all-things-considered obligatory [20]. Other ethical theories can and do accept this. Many rights-based deontologists have explicitly accepted lesser-evil obligations to act [21–23]. So, too, have virtue ethicists [24–26].[4] Indeed, the renowned virtue ethicist Philippa Foot was the first to articulate this obligation in relation to the trolley problem [27]. But whereas consequentialists reject the possibility of moral constraints in preventing evil, rights-based deontologists and virtue ethicists insist on them. For this reason, Singer offers an ecumenical principle designed to bring rights-based deontologists and virtue ethicists into his tent:

> *[I]f it is in our power to prevent something bad from happening, without thereby sacrificing anything of comparable moral importance, we ought, morally, to do it. By "without sacrificing anything of comparable moral importance" I mean without causing anything else comparably bad to happen, or doing something that is wrong in itself, or failing to promote some moral good, comparable in significance to the bad thing that we can prevent. This principle seems almost as uncontroversial as the last one. It requires us only to prevent what is bad, and not to promote what is good, and it requires this of us only when we can do it without sacrificing anything that is, from the moral point of view, comparably important [28].*

However, whereas Singer's principle—or at least, the dominant interpretation of it—requires people to sacrifice much, ours does not. This is significant, as many critiques of Singer's principle and the Effective Altruist movement it spawned are about the moral right of persons to pursue their ground projects and to reject overly demanding obligations [29–31]. Thus, our principle is more ecumenical than Singer's, which we regard as advantageous in the present context. For example, Singer's principle requires that we act to prevent suffering if we can do so while "not sacrificing anything of comparable moral importance." This clause has proven too consequentialist in flavor to satisfy multiple deontologists and virtue ethicists, whereas our principle is more ecumenical in this respect.

An action that satisfies the three conditions of premise 1 is likely obligatory. There are two reasons for this. First, the action has all the obvious right-making properties: It prevents very bad things, respects rights, and promotes virtuous agency. Second, the action avoids all the obvious wrong-making properties: It doesn't worsen the world, violate rights, or detract from virtuous agency. Moreover, like Singer's principle, it avoids the more controversial view that actions that merely add goodness to the world, as opposed to actions that (also) prevent badness in the world, are pro tanto obligatory. For example, most sufficientarians maintain that there is an obligation to ensure everyone has a "sufficient" quality of life, but that there is no obligation to improve people's lives beyond that threshold [32]. Typically, this is understood to mean preventing people from suffering serious harms (e.g., housing instability or lack of potable water) rather than affording them "surplus" goods (e.g., daily servings of the world's finest caviar or the latest Porsche model).

The second premise of the Convergence Argument is that promoting tickborne AGS (A) prevents the world from becoming a significantly worse place, (B) doesn't violate rights, and (C) promotes virtuous action or character. We defend these in order, beginning with (A).

3.2 | Argument for (2A)

1. Eating meat is morally wrong.
2. If (1), then eating meat makes people morally worse and makes the world a worse place.
3. So, people would be morally better and the world would be a less bad place if people didn't eat meat.
4. If an act makes people morally better and makes the world a less bad place than it would otherwise be, then that act is morally obligatory. [Corollary of consequentialism]
5. Promoting tickborne AGS makes people morally better and makes the world a less bad place.
6. So, promoting tickborne AGS is morally obligatory.

The above argument is deductively valid and specifically designed to appeal to consequentialists. For consequentialists, actions are wrong if, but not only if, they worsen the world (they could also fail to promote achievable benefits, e.g., by omission). So, if eating meat is morally wrong, then it makes the world a worse place.[5] Additionally, consequentialists can accept the moral truism that acting immorally makes *agents* morally worse. From the fact that meat-eating makes the world a worse place, it follows that the world would be a better place—and the agents within it morally better—if people didn't eat meat. The fourth premise is a necessary corollary of consequentialism.

The fifth premise is an empirical claim that we regard as plausible. Acquiring tickborne AGS makes people allergic to red

meat, which makes them less likely to eat most meats. Tickborne AGS is likely, if not certain, to prevent this wrongdoing. The mechanism by which AGS prevents this behavior is the same as the mechanism that prevents people with peanut allergies from eating peanuts, or people with cat allergies from owning cats, or people with shellfish allergies from eating shellfish, and so on. The *knowledge* that one will suffer after consuming mammalian meat will cause one to stop eating meat.

Assuming the allergy isn't reversed, tickborne AGS will result in far less meat-eating, making the world and the agents within it morally better than they would otherwise. Preventing meat eating by way of tickborne AGS has previously not been possible because one couldn't know that the hives, vomiting, or anaphylaxis were caused by eating red meat. However, with the recent scientific discovery of AGS, this knowledge has become more accessible. Connecting one's wrongdoing with the allergic reaction is possible, and once made, is likely to cause one to stop one's wrongdoing, presuming one wants to avoid those symptoms. In avoiding the symptoms of AGS, one avoids eating meat, and in so avoiding refrains from the immoral behavior and satisfies their moral obligation not to eat meat. Very little is lost in acquiring AGS, as long as one avoids the symptoms. It's true that the symptoms are unpleasant, but they are easily avoided. Moreover, the symptoms occur after committing an immoral act. If someone was allergic to abusing children and broke out in hives after, for example, breaking their child's arm or forcing their hand onto a hot stove, we would ordinarily not judge the hives as a significant moral sacrifice. We shouldn't think any differently about the allergic reaction to eating meat.

What differentiates AGS from other allergies is that the cause of the symptoms is wrong action. There is nothing wrong with eating peanuts or keeping company with cats. When one sneezes, breaks out into hives, vomits, or goes into anaphylaxis as a result of their allergies, the reactions result from a morally permissible action. Allergic individuals suffer not only from physical symptoms but also from the loss of permissible opportunities and experiences that one might have enjoyed had one not been allergic. Not so with AGS. The symptoms result from wrong action.

Does promoting tickborne AGS violate anyone's rights? No, it does not. To demonstrate this, we offer an elimination argument for 2B.

3.3 | Argument for 2B

1. If promoting tickborne AGS violates anyone's rights, it is because either: (a) people have a right against bodily interference and coercion, (b) people have a right against moral paternalism, or (c) people have a right to observe cultural practices that include meat-eating.
2. Not (a) or (b) because (i) promoting tickborne AGS is morally akin to promoting vaccination, which doesn't violate anyone's rights; and (ii) rights against bodily interference, coercion, and moral paternalism don't prohibit people from *permitting* the spread of tickborne AGS.[6]
3. Not (c) because (i) this right either doesn't exist for particular people/communities or it's sufficiently weak to be permissibly infringed for public health reasons and (ii) communities with this interest are sufficiently scarce and remote that they can be exempted.
4. So, promoting tickborne AGS doesn't violate anyone's rights. [From 1–5]

The argument's underlying assumption is that the moral rights at issue are rights against bodily interference and moral paternalism, and the right to observe cultural practices. For ease of argument, we operate under the provisional assumption that if none of these rights is violated by promoting tickborne AGS, then the promotion of tickborne AGS doesn't violate any rights.

Why should you accept premise 2 of the *Argument for 2B*? Consider an argument from analogy: If we could introduce a biochemical syndrome into the bodies of cannibals in a way that ensures they are allergic to consuming human meat, then—assuming there is no less bad alternative intervention that would succeed in preventing them from eating human meat—we are permitted and arguably obligated to do so because it is morally wrong to consume human meat under most circumstances. Similarly, since we can introduce a biochemical syndrome into the bodies of meat-eaters in a way that ensures they are allergic to consuming animal meat, then—since there is no less bad alternative intervention that would succeed in preventing them from eating human meat—we are permitted and arguably required to do so because it is morally wrong to consume animal meat under most circumstances.

Finally, consider premise 4 of the *Argument for 2B*. One common objection to ethical vegetarianism and veganism, particularly among political leftists, is that it is culturally imperialist [33, 34], particularly against communities whose cultures include ritualized hunting or meat-eating [35, 36]. However, there are limitations to this right that relevantly impact our case for the moral obligation to promote tickborne AGS. First, the vast majority of human beings are not part of oppressed or specially protected cultures, and even fewer are part of oppressed or specially protected cultures for whom hunting or meat-eating is a core or vital feature [37]. For example, the relatively recent culture of celebrating and consuming bacon is likely not a core or vital feature of American regional cultures, whereas whale hunting *is* a core or vital feature of Makah culture.[7] Thus, there is no cultural or moral equivalence between the two. Thus, the vast majority of human beings lack a special right to observe meat-eating as a protected cultural practice.

Second, communities that have this special right are not only rare but also tend to be geographically remote. For instance, the aforementioned Makah tribe number only 1,500 and live on a reservation in the Olympic Peninsula in Washington State. Thus, meat-eating practices within these small, remote communities do not pose a significant public health threat,

contribute to anthropogenic climate change, etc. Nor does promoting tickborne AGS place these communities at high risk of transmission, since they are highly remote.[8] Thus, even under the assumption that such communities have a moral right to observe special cultural practices that involve meat-eating, the promotion of tickborne AGS doesn't violate that right because (1) members of the relevant community are exempt from the moral obligation against meat-eating and (2) it is unlikely that these communities would be infected with tickborne AGS.

Finally, we can turn to premise 2C of the *Convergence Argument*, which concerns the promotion of virtuous action or character.

3.4 | Argument for 2C

1. Eating meat is morally wrong.
2. The virtuous person neither acts wrongly nor desires to act wrongly.
3. So, the virtuous person neither eats meat nor desires to eat meat.
4. Without a mechanism like AGS, it is extremely difficult for most humans to (A) eliminate their desire to eat meat or (B) forego acting on their desire to eat meat.
5. So, without a mechanism like AGS, it is extremely difficult for most humans to be (fully) virtuous.

Premise 1 is assumed by our broader argument. Premise 2 reflects the core commitment of virtue ethics. For example, Rosalind Hursthouse claims that "[a]n action is right iff [if and only if] it is what a virtuous agent would characteristically (i.e., acting in character) do in the circumstances" [38]. Moreover, virtue ethicists standardly embrace the view that the emotions of virtuous agents "will be felt on the *right* occasions, towards the *right* people or objects, for the *right* reasons."[9] Because "the agent with the inappropriate feelings does not act virtuously" [39, 125], and assuming that desiring to act wrongly is an inappropriate feeling (which it surely is), it follows that the perfectly virtuous agent does not desire to act wrongly. Conclusion 3 follows from 1 to 2.

Premise 4 contains two plausible empirical claims: that it is difficult for a person to eliminate their desire to eat meat and that it is difficult for a person to forego eating meat if they (strongly) desire to eat meat. This is reflected both by the underlying assumption behind faux meat (e.g., the Impossible Burger), which is that people are more likely to be vegetarian if they can satisfy their desire for meat-like tastes and textures [40], and by the high percentage of vegetarians who relapse and eat meat [41]. Premises 3–4 entail the conclusion, 5: Without a mechanism like AGS, it is extremely difficult for most humans to be (fully) virtuous. This is because most humans eat and desire to eat meat, which is morally wrong, and it is difficult for them to alter that behavior and desire. Tickborne AGS, however, eliminates the desire for (most) meat, thereby enabling—and, plausibly, *promoting*—virtue.

4 | AGS as MBE

Pursuing our recommendation—genetically engineer ticks so that they proliferate AGS—is feasible and morally justified. Nevertheless, one might consider other ways of getting AGS to people. Suppose it is possible to synthesize AGS and administer it to people by other means, cutting ticks out of the delivery process altogether. This may avoid some of the complications of using the lone star tick.

The synthetic version of AGS is an example of moral bioenhancement. A moral bioenhancement is any intervention that improves a person's moral capacities, which include moral reasoning, moral emotions, moral attitudes (desires, beliefs, hopes, etc.), or moral behavior [42]. There are other definitions available [43], including the simple proposal that moral bioenhancement is any biomedical intervention that brings about conformity with obligation [44], but some are overly narrow, limiting moral bioenhancement to those interventions that act upon only one aspect of a person's moral life [45]. By this definition, AGS is moral bioenhancement. On our view, gene editing ticks to proliferate to AGS also is a moral bioenhancement. But its status as a moral bioenhancer is inessential to our argument.

Moreover, synthetic AGS as a moral bioenhancer represents an advancement in the research on moral bioenhancement. Synthetic AGS is a feasible targeted intervention with a known morally enhancing effect. Authors must often assume that moral bioenhancements are safe and effective when discussing the ethics of their implementation. But with synthetic AGS, no such assumption is necessary. It is effective (it causes the improvement of a person's moral capacities) and safe (apart from the intended allergic reactions, it has no known side effects). Synthetic AGS is one of the first, if not the first, proposed moral bioenhancers for which this is true.[10]

Although synthetic AGS appears simpler, it faces empirical and normative obstacles. For the former, a vehicle is required for delivery. On our recommendation, that vehicle is the lone star tick. But if AGS is synthetic, then it must be delivered some other way. Suppose it can be delivered in all the ways vaccines are delivered. Then the problem is getting it to the people who need it. People who don't eat mammals won't volunteer for it, because they don't need it. But people who do eat mammals won't volunteer for it either, presumably because they want to continue eating mammalian meat.

If it's not voluntary, the only way to deliver AGS is by force, either covert or overt. But then this engages numerous normative obstacles [46], obstacles which our tick-editing recommendation do not confront. For example, if compelled, restrictions on freedom may be much more intrusive. Thus, not only is it unclear what such a transmission mechanism would be; it is also unclear whether other potential mechanisms would be morally preferable to ticks.

We are not claiming that synthetic AGS shouldn't be pursued or that it is impossible to implement permissibly. It may be feasible for a person to take synthetic AGS to grocery stores and secretly inject it into beef, pork, lamb, etc. Perhaps that method of delivery would overcome some of the empirical and normative

obstacles. Our claim is merely that rejecting tickborne AGS in favor of synthetic AGS is not as simple as it may initially appear.

5 | Objections and Replies

We now anticipate 10 objections to our argument and our broader position that promoting tickborne AGS is morally obligatory. We argue none of the objections succeeds.

> The Substitution Objection: *Even if the promotion of tickborne AGS is successful, it is more likely that people will substitute poultry and fish for red meat rather than become vegetarian/vegan.*

The concern behind the Substitution Objection is that the widespread promotion of AGS will not *reduce* moral wrongdoing (or animal suffering) but rather *relocate* it by causing fish and birds to suffer rather than mammals. An anonymous reviewer for this journal has raised the further worry that chickens suffer more per pound than most mammals do, and thus a widespread swap from mammals to chickens would generate *more* suffering (and, arguably, *worse* wrongdoing). However, we are skeptical of both claims. First, there is no evidence to support the speculative counterfactual claim that most people will turn to chicken or fish if they cannot safely consume red meat. Anecdotal evidence suggests that people with AGS turn to vegetarian diets instead [47]. Second, necessary for the Substitution Objection is the notion that the vast amount of suffering from poultry farming and fishing would compensate for the comparative reduction, but still vast, amount of suffering associated with beef and pork production. This calculation seems near-impossible. One cow or pig can feed more people, but plausibly the one-to-one suffering is more. Would a person who substitutes cause more suffering? Perhaps, but perhaps not. Third, even if they did turn to consuming poultry or fish, there are feasible means of reducing that suffering by genetically engineering the poultry to feel less pain, since we are now fully in the age of engineering our pigs and chickens to optimize our killing and eating them [48].

> The MBE Feasibility Objection: *Moral bioenhancement isn't feasible, and therefore moral bioenhancement vis-à-vis tickborne AGS isn't feasible.*

One series of complaints about the last decade or so of scholarship on MBE is that MBE is not feasible [49, 50] or ill-suited for human psychology [46]. However, MBE by way of AGS is actual and targets specific immoral behavior.[11] And unlike other proposed interventions associated with MBE, editing the genes of the lone star tick to proliferate AGS is feasible, given other scientific advancements in editing the genes of ticks and mosquitos.

> The Genetic Feasibility Objection: *Editing the genes of the lone star tick and other ticks who transmit AGS to ensure their survival in a wider range of environments isn't feasible.*

Our proposal is to edit the genes of the lone star tick and other ticks that transmit AGS. The target of gene editing should be to increase the survivability of ticks so that they can thrive for longer in a wider range of environments. This editing would, in part, require editing their reproductive fitness in other ways so that the edited ticks eventually take over those ticks that have not been edited. For example, ticks should be edited so that they can proliferate in more urban environments rather than in more suburban and rural environments. This may require some creative thinking. Perhaps ticks can be edited so that they are parasitic to rats, who carry them throughout the city. Ticks should also be edited so that they can survive in more arid environments, which may require different creative thinking.

A natural reaction to this proposal is to revive the feasibility objection to MBE: This gene editing isn't possible. However, there is little that, in principle, is scientifically infeasible. Moreover, it is currently possible to edit the genetic disposition of organisms to carry AGS; some livestock companies edit their pigs so that they do not elicit an allergic reaction to eating them.

> The Sanctity-of-Life Objection: *Editing the genes of the lone star tick and other ticks that transmit AGS is morally wrong because it violates the sanctity of life.*

It would be rather ironic for a person to object to editing the genes of ticks on the grounds that it undermines the sanctity of life, or that it compromises our relationship with nature. It seems incoherent to accept the industrialized torture and slaughter of gene-edited mammals as being compatible with the sanctity of life, but tick editing is incompatible. One could argue that both undermine the sanctity of life. But then comes the calculation: Gene-edited ticks preserve the sanctity of mammals' lives. Which matters more?

> The Hubris Objection: *Editing the genes of the lone star tick and other ticks that transmit AGS is morally wrong because it is an expression of hubris.*

Objections from "hubris" must first make a more specific claim. The notion of hubris is poorly defined, at least in contemporary philosophy. However, supposing it means something like a wrongful "drive to mastery" [51], it is important to weigh the drive to master ticks and their prevalence with the drive to master the torture and slaughter of mammals. Factory-farmed meat is, of course, already rife with gene editing, hormones, and antibiotics that are used to optimize this killing. Indeed, some swine have been genetically modified so that their eaters don't acquire AGS. However, even outside factory farms, livestock are routinely bred to optimize their properties. Meat-producing societies have driven the killing of animals and attained mastery. Again, both can be wrong, but presumably the hubris to master killing animals is worse.

> The Distortion Objection: *Editing the genes of the lone star tick and other ticks that transmit AGS is morally wrong because it disrupts and distorts humanity's relationship with nature.*

Our relationship with nature is already fraught with violence and imbalance. Eating meat significantly undermines human existence on the planet because meat production undermines the ecological and environmental conditions required for the

species to survive. If anything, promoting a species of animal that diminishes these existentially threatening behaviors improves our relationship with nature.

> The Ecological Uncertainty Objection: *Editing the genes of the lone star tick and other ticks that transmit AGS is morally wrong because it creates ecological uncertainty.*

What motivates this objection is uncertainty about what may happen if gene-edited ticks proliferate and transmit AGS to more people. We don't know what the ecological effects will be. Moreover, we don't know the downstream effects on human health. This uncertainty may be a reason not to edit the genes of ticks. However, at present, there is no reason to believe that the widespread proliferation of gene-edited ticks that transmit AGS would have negative ecological effects. In contrast, there is strong reason to believe that it would have positive ecological effects. Therefore, on balance, concerns about ecological well-being currently *favor* the widespread proliferation of gene-edited ticks that transmit AGS.

> The Public Mistrust Objection: *Editing the genes of the lone star tick and other ticks that transmit AGS is morally wrong because it causes public mistrust in science.*

There is historical precedent behind this concern: In the 1970s, the World Health Organization and the United States created and released genetically modified mosquitoes outside New Delhi, India. This project had two goals: "to reduce the mosquito population" and "to drive down the burden of disease." [52] We concur that public trust in science and medicine are important [53] and in need of restoration [54]. But historical precedent is also helpful for our case, since much recent attention has been devoted to how the release of genetically modified mosquitoes benefits public health and can be used to further the public's trust in science [55], and many of these strategies can be adapted to prevent erosion of public trust with respect to promoting tickborne AGS. Moreover, because *everyone*—not merely scientists—is obligated to promote tickborne AGS, our proposal doesn't provide grounds for public mistrust in science especially.

An obvious rejoinder to this is that our proposal promotes widespread mistrust, including mistrust of our neighbors, which is hardly better. Call this objection

> The General Mistrust Objection: *It is morally wrong for people to promote tickborne AGS because it causes mistrust in human relationships.*

Suppose your neighbor reads our paper and is convinced by our arguments, whereas you aren't. You might reasonably worry whether you can trust your neighbor: Will they place a lone star tick in your mailbox, or decline to brush it off your shoulder? However, our argument neither requires nor explicitly permits *the covert* promotion of tickborne AGS.[12]

Additionally, because interpersonal and public trust are typically predicated on acting for reasons that others accept, promoting trust arguably *requires*, rather than *prohibits*, promoting tickborne AGS. To see how, consider a recent argument for requiring psychopaths to undergo moral bioenhancement that eliminates or reduces their psychopathic traits: Because psychopaths expect and prefer others not to have psychopathic traits, they therefore have reason to prefer that *other psychopaths* not be psychopaths, which in turn is reason for *them* not to be a psychopath [59]. Similarly, we prefer that others refrain from wrongdoing and (other things being equal) act to prevent wrongdoing. That means we prefer for others to avoid meat-eating and to promote AGS. But then we must also prefer this for ourselves, in which case we should prefer to promote tickborne AGS.

> The Beneficiaries Objection: *Moral bioenhancement won't further the interests of nonhuman animals.*

While not an objection to our argument per se, Bob Fischer recently argued that MBE is unlikely to improve the welfare of nonhuman animals. Fischer seeks to temper the optimism of those who believe that MBEs that target and expand human empathy "would make us more fiercely committed to the good of those near and dear" [60], which excludes most nonhuman animals. Our argument meets Fischer's challenge. Tickborne AGS neither targets nor (directly) enhances human empathy; rather, it serves as an MBE by virtue of causing an allergy to red meat. In other words, tickborne AGS is an MBE that targets neither affective nor cognitive capacities, but rather *desires* (and therefore behavior). It causes people to stop wanting what is (morally) bad for them to want. Assuming that tickborne AGS becomes sufficiently widespread and is not reversed, this will result in enormous changes to human behavior – changes that benefit billions of nonhuman animals whose red meat is no longer desired.

6 | Conclusion

Alpha-gal syndrome (AGS) is caused by being bitten by a lone star tick. The sole primary effect of AGS is mammalian meat allergy, and there are no significant side effects of developing AGS. Assuming that eating meat is generally morally impermissible, acquiring AGS is likely to *morally enhance* a person's behavior, as they are far less likely to eat (red) meat if they are allergic to it.

Herein, we have argued that AGS is a moral bioenhancer and that its promotion is morally obligatory. Among other things, that means that researchers have an obligation to develop the AGS-carrying capacity of ticks, and that means human agents are obligated to expose others to AGS (and possibly lone star ticks), not to prevent the spread of AGS or lone star ticks, and to undermine attempts to "cure" AGS. Indeed, given that AGS is a moral bioenhancement with no significant negative effects on human health (so long as one avoids eating meat), it is not a disease and thus cannot be "cured."

Importantly, the *Convergence Argument* is not necessary for it to be *pro tanto* obligatory to promote tickborne AGS. Our argument is intended to satisfy philosophers of different normative persuasions. If any of the converging moral theories is adequate, then some argument can be made for our claim. Our argument is perhaps stronger than it needs to be because all it takes is for

one of consequentialism, rights-based deontology, or virtue ethics to be an adequate first-order theory. For example, if we relied entirely on consequentialism, one might object to our argument on deontological grounds. The *Convergence Argument* avoids that objection.

Data Availability Statement

Data sharing is not applicable to this article as no data sets were generated or analyzed during the current study.

Endnotes

[1] For discussion, see Bramble and Fischer [61].

[2] See, for example, the findings in: Schwitzgebel et al. [1] and Schwitzgebel et al. [2].

[3] See de Visé [4]; Jeffrey [5].

[4] Non-consequentialists—including one of us!—routinely value preventing the world from becoming a worse place. Within bioethics, for example, the duty of beneficence—which entails a duty to prevent harm from befalling others—is accepted by consequentialists and non-consequentialists alike, albeit with different deontic restrictions. Thanks to an anonymous reviewer for raising this concern.

[5] While we both believe animal suffering is the principal worse-making cause of widespread meat-eating, our intention is to avoid relying on this view in order to appeal to those who believe meat-eating makes the world worse for reasons other than animal suffering (e.g., harms to humans caused by anthropogenic climate change, for which factory farming is a major driver). Thanks to an anonymous reviewer for raising this issue.

[6] Let's assume (b) is true. Even if it is, this at most prohibits people from promoting tickborne AGS; it doesn't prohibit people from permitting tickborne AGS, since permitting tickborne AGS doesn't involve agents engaging in bodily interference or coercion.

[7] We are not anthropologists, but we take this claim to be sufficiently plausible that we offer no further defense of it here.

[8] If anything, the obligation to promote tickborne AGS offers further reason to avoid imperialist presences in indigenous and other protected communities.

[9] A necessary condition of being virtuous is not desiring to act impermissibly. Of course, there are further conditions, such as acting with virtuous desire or intent. However, the mere fact of desiring wrongdoing is itself sufficient for incomplete virtue, as the perfectly virtuous agent neither acts viciously nor desires to act viciously.

[10] But it's not as though the permissibility of using AGS as a moral bioenhancer is free of assumptions. It still must be the case that eating mammals is wrong, a position we do not argue for here.

[11] In saying this, we don't mean AGS, which is a product of natural evolution, intentionally targets immoral behavior. Rather, we mean that AGS has a narrow and morally desirable effect.

[12] Should moral bioenhancement ever be covert? For discussion, see: Crutchfield [42]; Crutchfield [56]; Zambrano [57]; Andrade [58].

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